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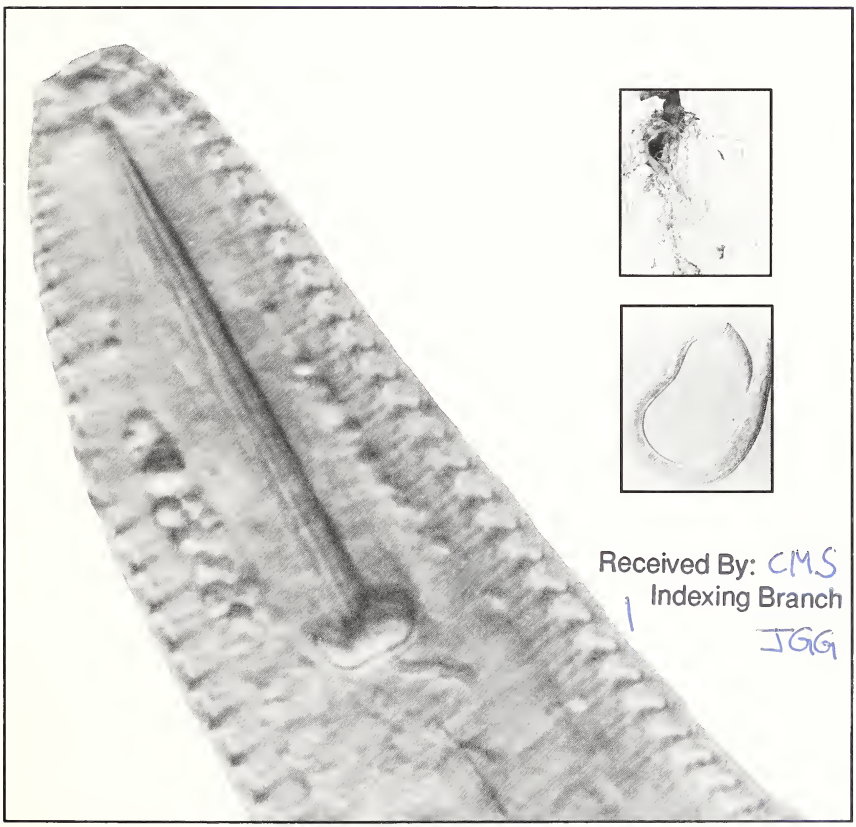
Growers' Guide to Plant Parasitic Nematodes Found in Maine



Abstract

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This publication describes the most common nematodes that are associated with agricultural crops in Maine.

Keywords: nematode, parasite.

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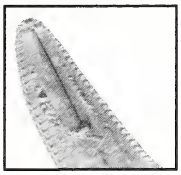

Growers' Guide to Plant Parasitic Nematodes Found in Maine

Robin N. Huettel, Robert W. Reise, and Alan Henn

Introduction

Nematodes are simple worms consisting of an elongate stomach and reproduction system inside a resistant outer cuticle (outer skin). Most nematodes are so small, between 400 microns to 5 mm long, that a microscope is needed to see them. Their small size, resistant cuticle, and ability to adapt to severe and changing environments have made nematodes one of the most abundant animals on earth. As Nathaniel Cobb explained in 1914,

> If all the matter in the universe except nematodes were swept away, our world would still be recognizable, and if, as disembodied spirits, we could then investigate it, we should find its mountains, hills, vales, rivers, lakes, and oceans represented by a film of nematodes. The location of towns would be decipherable, since for every massing of human beings there would be a corresponding massing of certain nematodes. Trees would still stand in ghostly rows representing our streets and highways. The location of the various plants and animals would still be decipherable, and had we sufficient knowledge, in many cases even their species could be determined by an examination of their erstwhile nematode parasites.

Most nematodes feed on bacteria, fungi, and other soil organisms. Others are parasitic, obtaining their food from animals (such as the dog heartworm), humans (such as the pinworm), and plants.

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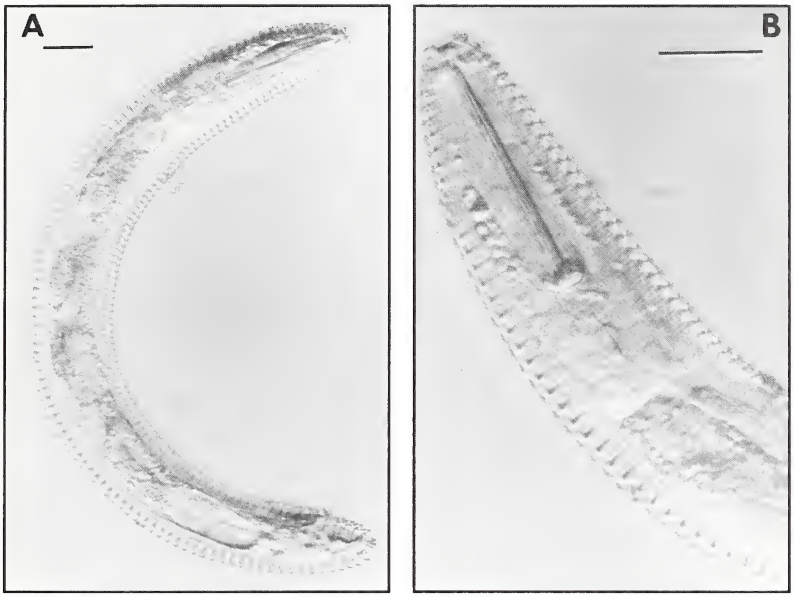
Agricultural cultivation encourages an increase in a few kinds of parasitic nematodes that feed on the crops being grown. Occasionally, new kinds of plant parasitic nematodes may be introduced into a field by contaminated plant parts, soil on farm equipment, and irrigation water.

Nematodes which parasitize plants may cause yield losses by themselves; or they may join with other soilborne organisms, such as viruses, fungi, and bacteria, to promote disease development in plants. Most often, nematode feeding reduces the flow of water and nutrients into the plant, increasing the plant's susceptibility to other stress factors such as heat, water, and nutritional deficiencies.

During the fall of 1987 and also during 1988, a survey of plant parasitic nematodes associated with Maine's agricultural crops was conducted. This pamphlet describes the most common nematodes found and briefly discusses the kinds of damage they cause in other States. Because the degree of nematode damage depends on soil type and environmental factors, the exact number of these nematodes needed to cause crop losses in Maine is not known or discussed.

Criconemella–Ring Nematode

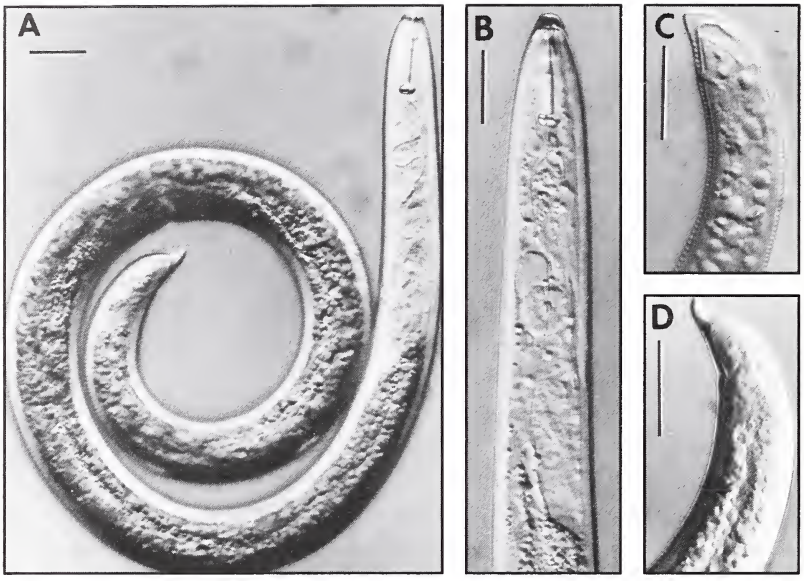


A. Mature female of *Criconemella curvata*. Ring nematodes receive their common name from the pronounced annules that look like rings around their body.
B. Head region of *C. curvata*. This nematode feeds from outside of plant roots and uses the long stylet to penetrate the epidermis of roots.
BAR = 20 microns.

Ring nematodes, which are common, are associated with many plants but, like the pin and spiral nematodes, must generally be present in large numbers to reduce plant growth.

Criconemella curvata is associated with orchard short life situations, where relatively low nematode numbers along with soil fungi and environmental factors seem to combine to shorten the productive life of replanted trees.

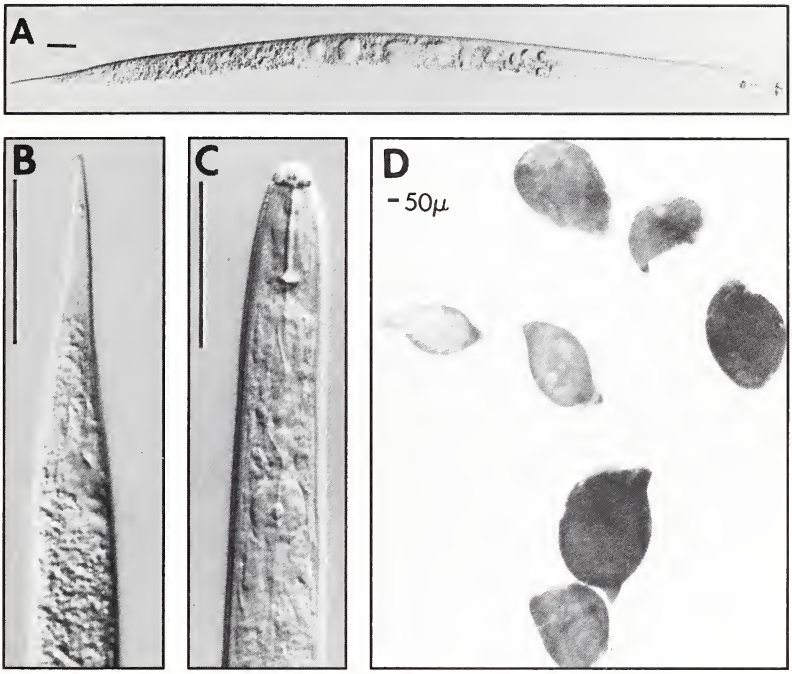
Helicotylenchus–Spiral Nematode



A. Mature female of *Helicotylenchus pseudo-robustus*. Coiling is characteristic of this nematode.
B. Head region of *H. pseudo-robustus* showing the slender stylet used for feeding upon plant cells.
C. & **D**. Tail types of two *Helicotylenchus* species found in Maine, *H. digonicus* and *H. pseudo-robustus*, respectively.
BAR = 20 microns.

When relaxed, spiral nematodes curl into a spiral, thus receiving their name. They are common nematodes associated with a wide range of host crops. Large numbers of these are thought to be needed to cause plant stress.

Heterodera, Globodera–Cyst Nematodes



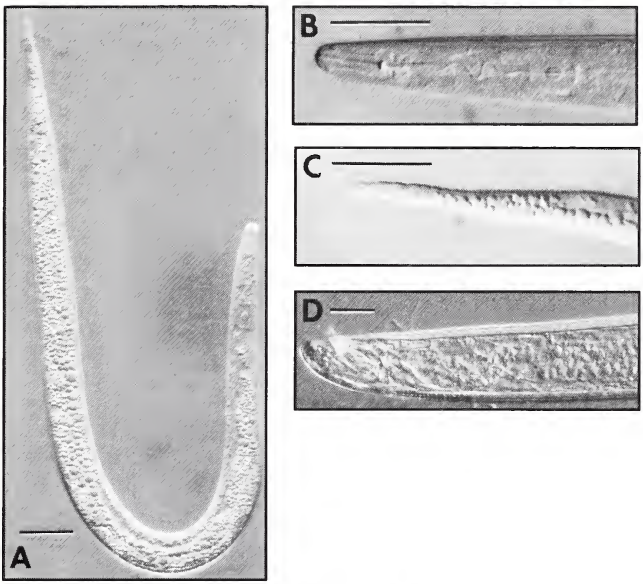
A. Full view of a cyst nematode juvenile, *Heterodera trifolii*, as it appears after egg hatch; it is about 600 microns long. BAR = 20 microns.
B. Tail region of *H. trifolii*. Length and shape of tail are important characteristics for identifying species. BAR = 40 microns.
C. Head region of a second stage juvenile. BAR = 40 microns.
D. Mature females. This nematode swells outside the root. Some cyst nematodes retain all their eggs inside their body. When the female dies, the body acts as a protective case.

Cyst nematodes generally feed on only a few closely related plant types, so crop rotation is often recommended for their management. In areas of high infestation the rotation must be long since the females retain most of the eggs inside their body, which forms a tanned and very resistant protective sac or cyst upon their death. These eggs may continue to hatch for many years. The clover cyst

nematode, a pest of clover, alfalfa, and some varieties of spinach, is the only member of the group currently identified in Maine.

The most important member of this group, *Globodera rostochiensis*, the golden cyst nematode, is the most damaging cyst nematode on potato. This nematode has been found in only limited areas of the United States, and those areas remain under quarantine. Many potato growing areas use resistant varieties to prevent this nematode from becoming established. It has not been found in Maine.

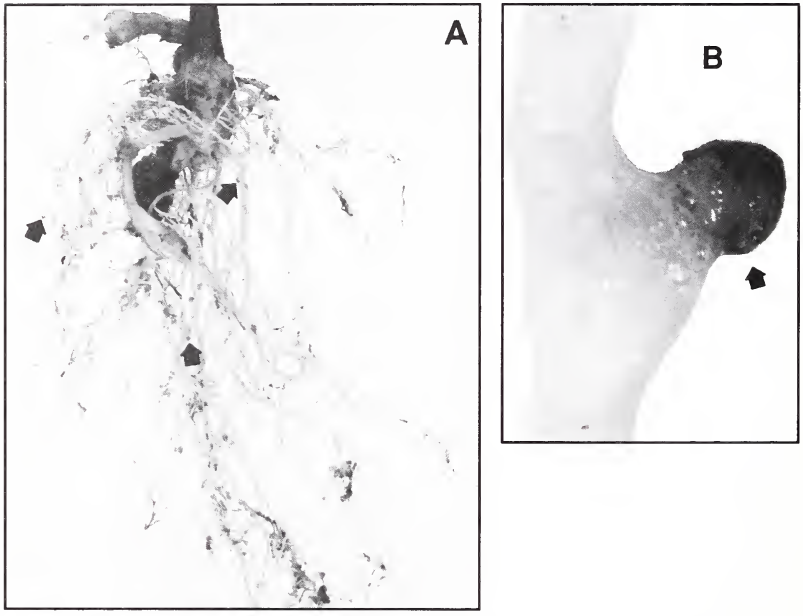
Meloidogyne–Root-Knot Nematode



A. Second stage juvenile of *Meloidogyne hapla*. *Meloidogyne hapla* is only about 400 microns long when it hatches from the egg and enters plant roots.
B. Head region showing the small stylet used to penetrate and feed on root cells.
C. Tail of a second stage juvenile of *M. hapla*.
D. Male tail showing the copulatory structures. Males are rare, nonfunctional, and very long.
BAR = 20 microns.

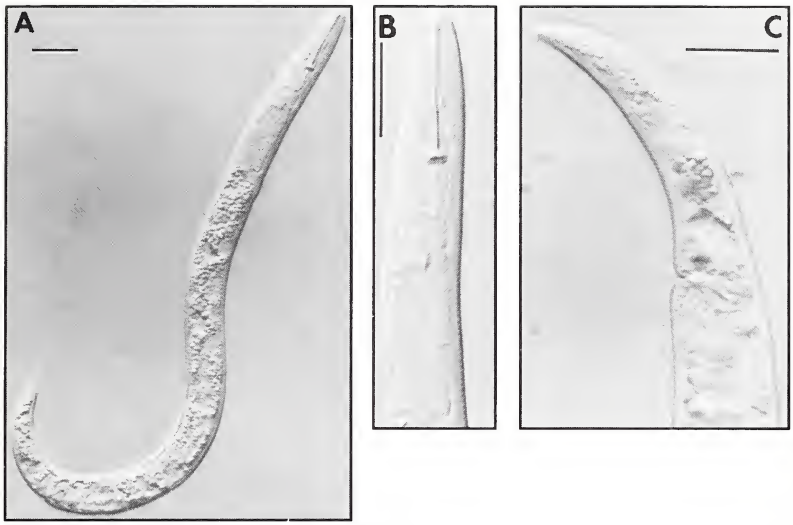
Root-knot nematodes are responsible for most of the nematode-induced crop losses around the world. They receive their name from the galls or knotting of the roots created by the females. The northern root-knot nematode, *Meloidogyne hapla*, is the only species identified thus far in Maine. On many hosts this nematode produces small inconspicuous galls, from which lateral roots proliferate. The Columbia root-knot nematode (*M. chitwoodi*) reproduces well in cooler climates and is a problem in the Pacific Northwest but has not been found in Maine. It may be spread on infected potatoes and soil, and this possibility should be considered when

selecting a seed source. The northern root-knot nematode is a pest of many different crops but may be especially troublesome to strawberry and to root crops, such as carrot and potato, because it may cause quality as well as yield problems. This nematode has apparently been a problem to Maine vegetable producers in the past. Root-knot nematodes may interact with soil fungi to reduce crop yield and/or quality in excess of what would normally be expected from the action of either the fungi or nematodes alone.



A. Females of the northern root-knot nematode cause small galls on plant roots (see arrow). On some plants, such as potato, the galls are difficult to observe.
B. The juveniles penetrate the roots, feed, and as they mature begin to swell within the root tissue. The mature female lays 250-500 eggs, which are embedded in a gelatinous matrix on the outside of the root (see arrow).

Paratylenchus–Pin Nematode



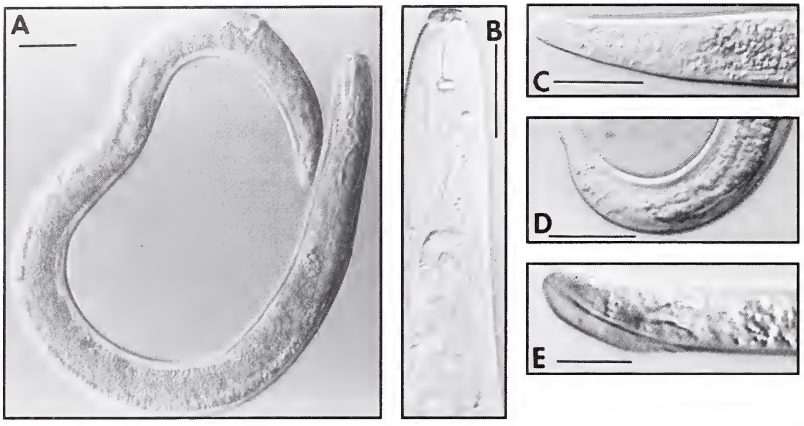
A. Mature female of *Paratylenchus projectus,* full view.
B. Head region of *P. projectus.* The long stylet allows it to feed from outside the roots.
C. Female tail showing the vulval opening for egg laying.
BAR = 20 microns.

Pin nematodes get their name from their small size and pin shaped stylet. These nematodes are often found in very high numbers in association with apparently healthy roots. However, a high number of the nematodes may induce proliferation of feeder roots and a reduction in the formation of lateral roots, leaving the plant susceptible to other stress agents and consequent yield reduction.

Pin nematodes are widely distributed in Maine and are found in all areas of the State and on most crops sampled. They are most frequently found on potato, apple, and raspberries. These nematodes are known to be a problem on strawberries in other parts of the United States.

Pin nematodes may produce symptoms of leaf chlorosis on some crops, such as raspberry, celery, parsley, and carrots.

Pratylenchus–Lesion Nematode



A. Mature female, full view of *Pratylenchus penetrans.*
B. Head region of *P. penetrans*, showing the short, stout stylet.
C. & D. Tail region of *P. penetrans* and *P. crenatus*, respectively, the two most common plant parasitic nematodes found in Maine.
E. Male tail; males are found only in *P. penetrans.*
BAR = 20 microns.

Lesion nematodes feed on both the outside and inside of roots. When feeding on the inside of roots, the nematodes burrow from cell to cell, forming tunnels in the root cortex. These tunnels may merge to form dark colored lesions similar to those caused by *Rhizoctonia.* It is from these lesions that this group of nematodes receive their common name, the root lesion nematodes.

Symptoms of their injury to plants are characteristic of root damage; in general, the plants show a gradual decline or lack of vigor rather than a dramatic injury. Infested fields are often thought to have bad and/or droughty soil, or simply to yield less than other fields.

Pratylenchus–Lesion Nematode

Two different species of lesion nematodes are usually found together in Maine potato fields, and they may occur in any mixture. One of them, *P. penetrans*, seems to be more damaging and to form disease complexes with soil fungi more readily than the other, *P. crenatus.*

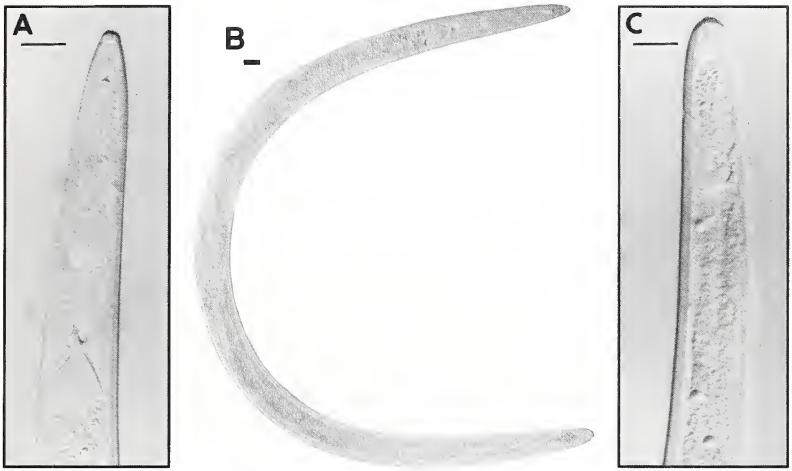
Pratylenchus penetrans may form a complex with soil fungi such as *Verticillium* and *Rhizoctonia*, and can thereby enhance the severity of the fungal diseases or "break" host-plant resistance to the fungi. Of special interest to potato growers is the interaction of *P. penetrans* with the fungus *Verticillium dahliae* (one of the fungi causing Verticillium wilt of potatoes) to cause a disease called Potato Early Dying (see photograph below).

A. This Aroostook County potato field exhibited symptoms associated with Potato Early Dying. Samples showed the plants to be infected with high numbers of *Pratylenchus penetrans* and *Verticillium dahliae.*

Symptoms of Potato Early Dying are often similar to those of normal senescence. They may occur in spotty areas of the field and are usually expressed unevenly in the lower leaves. Uneven chlorosis and uneven wilting of the leaflets are typical. Later symptoms may be limited to the early death of isolated plants or may extend throughout the field. The rate of plant decline seems to be related to the degree of environmental stress in the field. Such stress agents include heat, water, and nutritional factors.

A 1988 Potato Early Dying survey of Aroostook County fields continually showed an association between *P. penetrans* and both *V. dahliae* and *V. albo-atrum*. The diseased fields occurred in all major soil types and were planted to different cultivars. The severity and type of symptoms differed among the cultivars.

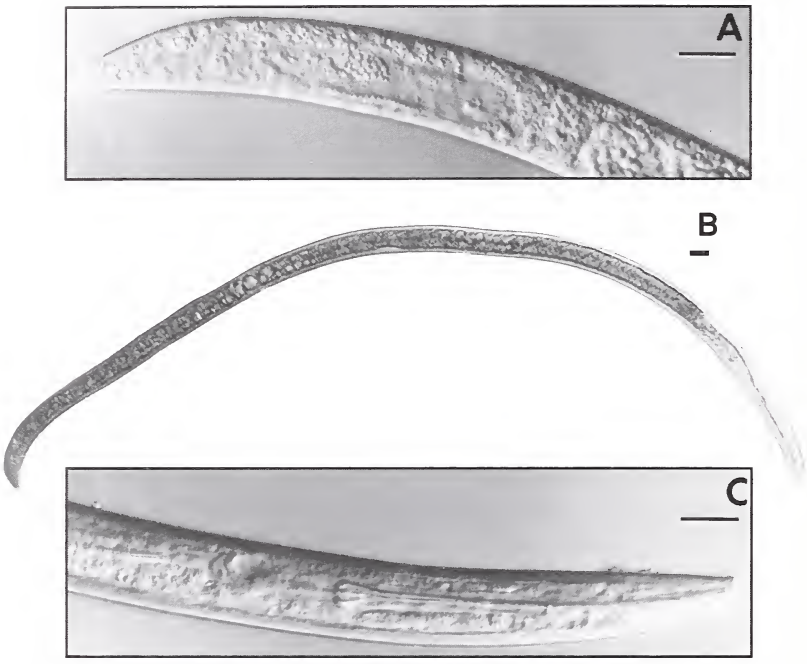
Tylenchorhynchus–Stunt Nematode



A. Head region of the stunt nematode *Tylenchorhynchus maximus*. Note the fine stylet.
B. The mature female measures about 2 mm long and is considered to be a large nematode.
C. Tail region of *T. maximus*. This nematode has a blunt rounded tail.
BAR = 20 microns.

Stunt nematodes are large and are commonly associated with many plants. The species most often found in Maine is associated with oats and other grains. The feeding behavior of this nematode allows it to partially enter the root and penetrate deeply enough inside to stunt the root system. The roots often become shriveled and fail to elongate as normal roots.

Xiphinema–Dagger Nematode



A. Tail region of a female dagger nematode, *Xiphinema americanum.*
B. The mature female of *X. americanum* is long, about 3.4 mm.
C. The stylet of *Xiphinema* spp. is very long, so it can penetrate deeply into root tips.
BAR = 20 microns.

Dagger nematodes are more of a problem to perennial and hardwood species than to annual crops. They have been associated with losses of strawberries, raspberries, apples, pines, and spruces. They deserve special notice because of their ability to transmit tomato ringspot, tobacco ringspot, peach rosette mosaic, and cherry rasp leaf spot viruses to a wide range of perennial and orchard crops. Decreases in the expected lifespan and productivity of the plants are common symptoms of these problems.

Xiphinema–Dagger Nematode

The most common type of dagger nematode found in Maine is *X. americanum*. A necrotic ring spot disease of blueberries is caused by the nematode transmitting tobacco ringspot virus. This nematode is also associated with losses to strawberries, on which it causes a sparse, often blackened root system. *Xiphinema americanum* has been reported by the U.S. Department of Agriculture to be one of the most damaging nematodes of raspberry, necessitating replanting every 3 to 4 years in some areas of the United States.

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